ther, I ſhall endeavour to procure them ſubſcribers to their work, and ſhew them every civility in my power.

LXXXVI. *Experimental Examination of a white metallic Subſtance ſaid to be found in the Gold Mines of the* Spaniſh Weſt-Indies, *and there known by the Appellations of* Platina, Platina di Pinto, Juan Blanca. *By* William Lewis, *M. B. F. R. S.*

PAPER I.

Read May 30, 1754.

Experiment 1.

THE ſubſtance brought into England under the name of *platina* appears a mixture of diſſimilar particles.

The moſt conſpicuous, and by far the largeſt part of the mixt, are, white, ſhining grains, of ſeemingly ſmooth ſurfaces, irregular figures, generally planes with the edges rounded off. Upon examining theſe with a microſcope, the ſurface appear'd in ſome parts irregular; the prominencies ſmooth, bright, and ſhining; the cavities dark-colour'd and roughiſh. A few of them were attracted, tho' weakly, by a magnetic bar.

The grains above deſcrib'd are the true *platina*. The heterogeneous matters intermingled among them, in the ſeveral parcels, were,

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1. A blackiſh duſt, ſeparable by a fine ſieve. This was farther divided, by a magnetic bar, into two different ſubſtances: the part attracted, was of a fine ſparkling black colour, much reſembling the black ſand from Virginia: the part not attracted was of a dark browniſh hue, with ſeveral bright *moleculæ*, which appear'd to be fragments of the grains of platina.
2. Among the larger grains, ſeparated by a coarſe ſieve, were obſerv'd ſundry irregular dark-colour'd particles, ſome blackiſh, others with a caſt of browniſh red, in appearance reſembling fragments of emery or loadſtone. Several were attracted, weakly, by the magnet.
3. There were a few rough yellow particles, reſembling gold, which upon farther examination they were found to be, tho' probably not entirely free from platina.
4. A few globules of quickſilver, containing gold, with ſome particles of platina intermix'd and pretty ſtrongly adhering.
5. Some fine tranſparent particles, probably ſpar.
6. A very few irregular particles, of a jet-black colour. Theſe broke eaſily, and look'd like the finer kinds of pitcoal. Laid on a red-hot iron, they emitted a yellowiſh ſmoke, and ſmelt like burning coal.

Remarks. 1. It appears from the foregoing obſervations, that this mineral has not come to us in its native form; being, probably, taken out of the mines in large maſſes, which have been broke, and treated with

with mercury, in order to extract the gold, of which poſſibly it at firſt contain'd a conſiderable quantity. The quantity left by the workmen is extremely ſmall; ſome pounds of the mixt having yielded only a few grains. A moderate fire renders more of theſe golden particles diſcoverable, than can be ſeen at firſt; the mercury evaporating, by which ſeveral of them were concealed.

2. Some part of the browniſh powder is probably adventitious, as well as the mercury; being worn off from the ſtampers and mills employ'd for comminuting the mineral, and triturating it with the mercury.

3. The roughneſs and dark colour of the cavities of the grains of platina ſeem to proceed from a ſubſtance ſimilar to the black duſt, adhering in them. It is probably owing likewiſe to this heterogeneous magnetic matter, that ſome of them are attracted by the loadſtone.

Experiment 2.

Some of the purer grains of platina, by gentle ſtrokes of a flat hammer, upon a ſmooth anvil, bore to be conſiderably flatten'd, without breaking or cracking about the edges: ſome quickly crack'd, and diſcover'd internally a cloſe granulated texture. All are reducible, by rude ſtrokes in an iron mortar, tho' with difficulty, into powder. They ſeem'd to be rather more brittle when ignited, than when cold.

Experiment 3.

The ſpecific gravity of platina, with its heterogeneous admixtures, as brought to us, was found to be

be to that of water as 16.995 to 1.000. The quantity weigh'd for this purpoſe was no leſs than 2000 Troy grains.

The larger grains of platina, ſeparated as much as poſſible from the other matters by the ſieve, and cleans'd by heating, boiling in aqua fortis, mixing them with ſal ammoniac, and forcing off the ſalt by fire, and afterwards waſhing them; weigh'd in air 642, in water 606.75: whence their gravity turns out 18.213. The microſcope ſtill diſcover'd a conſiderable portion of blackiſh matter in their cavities.

Theſe trials were ſeveral times repeated on different parcels of platina: the reſult was nearly the ſame in all.

Remark. The gravity of this mineral, great as it appears to be from the foregoing experiments, would probably turn out ſtill greater upon a farther purification of the platina, ſince it is manifeſtly mix'd with ſome of the lighter heterogeneous matters.

Experiment 4.

1. A quantity of platina, containing its uſual admixture of magnetic duſt, was kept for ſome time of a moderate red heat in an iron ladle. The bright particles became ſomewhat duller-colour'd; the magnetic ones were no longer attracted. In other reſpects there was no ſenſible alteration.

2. An ounce of platina was urg'd with a ſtrong ſea-coal fire, in a blaſt-furnace, for above an hour: the heat was ſo vehement, that the black-lead crucible vitrify'd, and the ſlip of Windſor brick, which cover'd it, melted, and ran down. The grains of platina were found ſuperficially cohering into a lump,

of the figure of the bottom of the crucible, of a brighter colour than at firſt. On a ſlight blow, they readily fell aſunder again, and ſeem'd not to have alter'd their ſhape.

3. In ſeveral repetitions of the experiment, the platina began to cohere in a moderate white heat: the grains were at this time very eaſily ſeparable, and ſeem'd to cohere the more ſtrongly in proportion as the heat was rais'd. In the moſt intenſe fires, which the common veſſels could not long ſupport, the platina did not melt, or ſoften, or alter its figure, or loſe, ſenſibly, of its weight. The colour was conſtantly brighten'd by a ſtrong heat, and generally render'd duſky by a ſmall one: on quenching it, when violently heated, in cold water, the grains, which compos'd the internal part of the lump, acquir'd a violet or purple colour.

Experiment 5.

1. As the power of fire upon metallic, as well as earthy ſubſtances, is remarkably promoted by the immediate contact of fuel, and the impulſe of air upon the ſubject; platina was expos'd to its action in thoſe circumſtances. A crucible, having a bed of charcoal in it, was laid on its ſide, in a good blaſt-furnace, with its mouth towards the noſe of the bellows; and four ounces of platina ſpread upon the charcoal. The fire was vehemently urg'd for above an hour, during which an intenſe white flame paſs'd thro' the crucible, and iſſu'd at an aperture made for that purpoſe. The crucible was vitrify'd: the grains of platina only ſuperficially coher'd, and became brighter, as in the preceding experiment, without ſeeming to have ſoften'd or alter'd their ſhape.

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2. The experiment was ſeveral times repeated, and varied: once, common ſalt was thrown on the fuel before the crucible, and its fumes ſtrongly impell'd on the platina: ſome platina was likewiſe placed before the noſe of the bellows in violently-excited ſea-coal fires, ſo ſtrong as to almoſt inſtantly melt off a piece of the end of a forg'd iron rod, without effect; except that once there were a very few globular drops, about the ſize of very ſmall ſhot: theſe broke eaſily on the anvil, and look'd, both internally and externally, like platina.

Remark. It is probable, that the fuſion here was owing to ſome accidental admixture, poſſibly iron: for the unmelted grains, expos'd afterwards to a fire rather more intenſe, ſuffer'd no ſenſible alteration.

Experiment 6.

Platina was likewiſe expos'd to the fire in conjunction with ſeveral ſubſtances, which are found to promote the fuſion of other bodies, or to occaſion conſiderable alterations in them.

1. Platina mingled with powder'd charcoal, with compoſitions of charcoal, ſoot, common ſalt, and wood aſhes, ſubſtances employ'd for changing iron into ſteel; ſuffer'd no change in weight or appearance, whether urg'd with an intenſe fire, or cemented for many hours in a weaker one.

2. Platina was injected into melted borax, and urg'd with an intenſe fire for ſeveral hours, without undergoing any alteration. Nor had black flux, common ſalt, pure fix'd alcaline ſalts, or cauſtic alcalies, any ſenſible effect.

3. Vitreous matters were no more powerful than the ſaline. Platina was kept in ſtrong fires, for ſeveral hours, with common green glaſs, with glaſs of antimony, and with glaſs of lead, without ſeeming to be in the leaſt acted upon by either.

4. Platina was likewiſe ſtratified with plaſter of Paris, a powerful flux for the moſt difficultly-fuſible metallic body hitherto known, forg'd iron; as alſo with quicklime, and with calcin'd flint; with as little effect as in the former trials.

Experiment 7.

Nitre, which reduces all the known metallic bodies, except gold and ſilver, into a calx, was mix'd with an equal weight of platina, the mixture injected into a ſtrongly-ignited crucible, and the fire kept up for a conſiderable time; no deflagration happen'd; and the platina, freed from the ſalt by repeated ablutions with water, prov'd of the ſame weight and appearance as at firſt.

Experiment 8.

1. An ounce of platina was ſpread upon twice its weight of ſulphur, with which ſome powder'd charcoal had been previouſly mix'd to prevent its becoming fluid in the fire ſo as to ſuffer the platina to ſubſide. The crucible, having another with a hole in the bottom inverted into its mouth, was kept in a cementing furnace for ſeveral hours, when the ſulphur was found to have entirely exhal'd, leaving the platina ſeparable from the charcoal by waſhing, without alteration or diminution.

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2. We likewiſe varied the experiment, injecting repeatedly pieces of ſulphur upon platina ſtrongly heated; and conſtantly found, that pure ſulphur had no more effect upon this mineral than on gold itſelf.

3. As fix'd alcaline ſalts enable ſulphur to diſſolve gold; platina was expos'd to the fire with a mixture of ſulphur and alcali, call'd *hepar ſulphuris*. After a conſiderable heat had been continu'd for ſome time, and the matter occaſionally ſtirr'd, very little of the platina was found remaining in its proper form; the greateſt part being taken up by the ſulphureo-ſaline mixture, ſo as to diſſolve along with it in water.

General Remarks.

It appears, from the foregoing experiments and obſervations,

1. That probably this mineral is originally found in large, hard maſſes, compos'd of true platina, a ſubſtance ſimilar to the black Virginia ſand, and another ferruginous matter of the emery kind, ſome ſpar, and particles of gold.

2. That theſe maſſes are, not without great labour, reduced into ſmall grains, which are afterwards ground with mercury, in order to extract the gold.

3. That the pure platina is a white metallic ſubſtance, in ſome ſmall degree malleable: that it is nearly as ponderous as gold, equally fix'd and permanent in the fire, equally indeſtructible by nitre, unaffected by ſulphur, diſſoluble by *hepar ſulphuris*. That it is not to be brought into fuſion by the greateſt degree of fire procurable in the ordinary furnaces, whether expos'd to its action in cloſe veſſels, or in contact with the fuel; by itſelf, or with the addition of inflammable, ſaline, vitreous or earthy fluxes.

PAPER II.

Read June 20, 1754. THE more obvious properties of this extraordinary mineral, and its *habitus* to fire, ſingly, and in conjunction with the various ſubſtances call'd by the chemiſts *fluxes*, made the object of the firſt paper. In this, it is propos'd to examine the effect of acid ſpirits, ſimple and compound, applied after various manners; in order to determine not only its relation or *habitus* to them, but likewiſe its leſs obvious agreement or diſagreement with the metallic bodies, whoſe hiſtory is more known.

The platina employ'd in the following experiments was previouſly freed from its fine duſt by a ſieve; from the mercury, by ignition; and from the golden and ſome of the other heterogeneous particles, by the eye aſſiſted with glaſſes.

Experiment 1.
Platina *with the* Vitriolic Acid.

1. Several parcels of platina were digeſted for ſome hours, in a gentle heat, with ſpirit of vitriol, both concentrated, and diluted with different proportions of water. No ſolution happen'd, nor any ſenſible alteration, either in the liquors or the platina.

2. Three ounces of well-dephlegmated ſpirit of vitriol were boil'd with one ounce of platina, in a tall, narrow-neck'd glaſs, for ſome hours. The liquor remain'd nearly of the ſame quantity as at firſt; and no

no change could be perceiv'd either in it, or in the platina.

3. The glaſs being cut off, a little above the liquid, the heat was gradually increas'd, till the liquor, which now began to evaporate, had, in five or ſix hours, totally exhal'd, and the platina become dry, and red-hot. When grown cold, waſh'd with water, and exſiccated, it was found exactly of the ſame weight as at firſt, and its grains not divided, or apparently alter'd.

Remark. Platina appears therefore to entirely reſiſt the vitriolic acid; which, by one or other of the above proceſſes, diſſolves or corrodes every other known metallic body except gold.

Experiment 2.
Platina *with the* Marine Acid.

1. Weak and ſtrong ſpirits of ſalt being digeſted, ſeparately, with one-third their weight of platina, in a gentle heat, for ſeveral hours, the liquors remain'd uncolour'd, the platina unalter'd, and undiminiſh'd. The heat was afterwards increas'd, and the liquors kept ſtrongly boiling till they had totally exhal'd, without occaſioning any ſenſible change in the platina.

2. Three ounces of a mixture of two parts decrepitated ſea-ſalt and three parts of vitriol highly calcin'd, were preſs'd ſmooth into a crucible; an ounce of platina ſpread evenly upon the ſurface, and cover'd with ſome more of the mixture; the crucible cloſely luted, and kept in a moderate red heat for ſeveral hours. On examining it when grown cold, the ſaline

mixture was found to have melted, and form'd a ſmooth, uniform lump. The platina, which had ſunk to the bottom, being ſeparated from the mixture by waſhing, prov'd of the ſame appearance as at firſt, tho' a little deficient in weight.

3. The experiment was repeated with what is call'd the *regal cement*, a leſs fuſible mixture, compos'd of common ſalt and colcothar each one part, and four parts of powder'd red bricks. An ounce of platina, ſurrounded, as above, with ſix ounces of this compoſition, and cemented in a cloſe-luted crucible with a red heat, for twenty hours, was ſtill found unalter'd in appearance, tho' there was ſome deficiency, as before, in the weight.

Remark. The marine acid, when thus detain'd in the fire by the combination of other bodies, till ſtrongly heated, and then ſet at liberty in the form of fume, diſſolves or corrodes all the known metallic ſubſtances, gold alone excepted. As the platina, in theſe experiments, retain'd its original poliſh'd ſurface, without any mark of corroſion; it was preſum'd, that this mineral likewiſe had reſiſted the marine fumes; and that the deficiency was owing to ſome of the ſmaller grains having been waſh'd off, along with the ponderous colcothar or metallic matter of the vitriol; an accident not eaſily avoided.

4. Platina was therefore treated with mercury-ſublimate, a combination of the highly-concentrated marine acid with a volatile ſubſtance, which in a proper degree of heat it readily forſakes to unite with other metallic bodies. An ounce of platina was ſpread upon three ounces of powder'd ſublimate; the glaſs cover'd, and ſet in ſand: After a moderate fire for

ſome

ſome hours, the ſublimate was found to have entirely ariſen, leaving the platina of its original weight, as well as appearance.

5. Fifty grains of a mixture of one part of platina and two of gold, well neal'd, and cautiouſly hammer'd into a thin plate, were ſurrounded with regal cement, the veſſel cover'd, cloſely luted, and kept for a conſiderable time in a red heat. Upon examining the metal, it was found to retain the whiteneſs and brittleneſs, which gold conſtantly receives from ſo large a proportion of platina; and to have loſt in weight about half a grain, or one-hundredth.

Remark. The loſs here appears to have proceeded, not from the platina, but from alloy in the gold employ'd, which was above ſtandard, but not perfectly fine: For the metal cemented a ſecond time, with freſh mixture, ſuffer'd no farther diminution. If the marine acid were capable of diſſolving platina, inſtead of one-hundredth, nearly one-third would have been exeded. This experiment therefore determines, with certainty, the reſiſtance of platina to the marine fumes; and that the regal cement, ſo call'd from its being ſuppos'd to purify gold from all heterogeneous metallic matters, is incapable of ſeparating platina from it.

Experiment 3.

Platina *with the* nitrous acid.

1. Spirit of nitre diluted with water, proof *aqua fortis*, and the ſtrong nitrous ſpirit, were digeſted ſeparately, with one-third their weight of platina, in a gentle heat, for ſeveral hours. During the digeſtion,

ſome bubbles were obſerv'd, as if a ſolution was beginning: but the liquors acquir'd no colour; and the platina, waſh'd and dry'd, was found to have neither alter'd its appearance, or loſt of its weight. The fire being afterwards increas'd, and the acid ſpirits kept ſtrongly boiling till they had entirely evaporated, no change could be obſerv'd in the platina.

2. Platina was likewiſe treated with nitrous mixtures, by proceſſes ſimilar to thoſe, in which it had been expos'd to the marine fumes. After cementation for many hours, in a red heat, with a mixture of three parts calcin'd vitriol, and two of melted nitre, the grains were recover'd not only unalter'd, but likewiſe without any deficiency in weight.

Remark. From theſe experiments it is plain, that platina, equally with gold, reſiſts the force of the vitriolic, marine, and nitrous acids, tho' apply'd in ſuch a manner, as to be capable of perfectly diſſolving all other known metallic bodies.

Experiment 4.
Platina *with* aqua regia.

1. Aqua regia, which perfectly diſſolv'd gold, pour'd upon platina, began to act on it in the cold, and, by the aſſiſtance of a moderate heat, ſlowly diſſolv'd it; acquiring at firſt a yellow colour, which deepen'd by degrees, as the menſtruum became more ſaturated, into a dark browniſh red. A few drops of the ſaturated ſolution tinged a large quantity of water of a fine golden colour.

2. The experiment was ſeveral times repeated with different aquæ regiæ, made by diſſolving ſea-ſalt and ſal

ſal ammoniac, ſeparately, in four times their weight of aqua fortis; and by abſtracting the nitrous ſpiri from the ſame proportion of each of the ſalts With all theſe menſtrua the ſolution ſeem'd to ſucceed equally.

3. In order to determine the quantity of menſtruum neceſſary for the ſolution; three ounces of an extremely ſtrong aqua regia, diluted with water, were pour'd upon one ounce of platina, in a retort, to which was adapted a recipient. A gentle heat being applied, the menſtruum acted violently, and red fumes aroſe in abundance. When about two-thirds of the liquor had come over, the action was ſcarce, if at all, ſenſible, though the fire was conſiderably rais'd. The diſtill'd liquor, which appear'd of a light rediſh colour, being pour'd back again into the retort, the ſolution began afreſh; the vapour, which now came over, appear'd pale, compar'd with the firſt. The cohobation was repeated four times, the diſtill'd liquor proving paler and paler every time: At length, both the fumes and action ceas'd, though the fire was rais'd, and a conſiderable part of the platina remain'd undiſſolv'd. The ſolution was therefore pour'd off, ſome more of the menſtruum added, the diſtillation and cohobation renew'd, and this occaſionally repeated, till the whole was taken up, excepting a little blackiſh matter, of which hereafter. The quantity of ſtrong aqua regia, employ'd for diſſolving the ounce of platina, was five ounces; but the laſt parcels appear'd from their yellow colour not to be fully ſaturated, and, upon trial, were found to take up near fifty grains of freſh platina.

Remark. It appear'd, that by this method of managing the proceſs, one part of platina was diſſoluble in about four and a half of aqua regia: But that when the digeſtion was perform'd in open veſſels in the common manner, and the fumes, which ariſe copiouſly during all metallic diſſolutions, ſuffer'd to exhale, more than half as much again of the menſtruum was requiſite. This proceſs might therefore poſſibly be applicable to advantage, in making ſolutions of metals in the way of buſineſs.

Examination of Solution of Platina.

Experiment 1.

As the vitriolic acid carries down metallic bodies, gold not excepted, from their ſolutions in other menſtrua; this acid was mix'd with ſolutions of platina.

1. When the ſolution of platina was previouſly diluted with water; the addition of dephlegmated ſpirit of vitriol occaſion'd no precipitation, or change of colour, tho' a large quantity of the acid was, at different times, dropp'd in, and the mixture ſuffer'd to ſtand for ſeveral days.

2. Dephlegmated ſpirit of vitriol, added to an undiluted ſolution of platina, immediately render'd it turbid, and threw down a duſky-colour'd precipitate. The precipitate was not re-diſſolv'd on the affuſion of water; nor was the precipitation prevented by adding water immediately after the acid had been dropp'd in.

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Experiment 2.

Solutions of platina, evaporated by a gentle warmth, to a proper pitch, and then ſet to ſhoot, yielded cryſtals, of a dark, almoſt opake, red colour, in form of leaves, like flowers of benzoin, but thicker. The cryſtals, waſh'd with proof ſpirit, became ſomewhat paler, but ſtill remain'd of a high colour, reſembling the deeper chives of ſaffron. Expos'd to the fire, they ſeem'd to melt, emitted white fumes, and at length fell into a duſky aſh-colour'd calx.

Experiment 3.

Solutions of platina, dropp'd upon hot marble, immediately corroded it; but did not, like ſolutions of gold and ſome other metals, communicate any colour. Nor did they give any ſtain to the ſkin, to feathers, ivory, or other like animal ſubſtances, which liquors containing gold tinge purple.

Experiment 4.

As a minute proportion of gold contain'd in liquors is diſcoverable by their ſtriking a purple colour with tin.

1. Some bright plates of pure tin were put into a ſolution of platina diluted with water. The plates, in a little time, look'd of a dark olive colour, and ſoon after were cover'd with a rediſh brown matter: The liquor became at firſt darker colour'd, and afterwards by degrees, as the precipitate fell, nearly colourleſs; without exhibiting the leaſt appearance of a purpliſh hue.

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2. Platina was digeſted in a quantity of aqua regia inſufficient to diſſolve the whole; and the reſiduum diſſolv'd in a freſh parcel of the menſtruum. The two ſolutions, treated as above, yielded ſomewhat different phænomena, but no tendency to a purpliſh caſt could be perceiv'd in either. The latter, which looked yellow from not being fully ſaturated, was, when diluted with water, almoſt colourleſs. Nevertheleſs, on the addition of the tin, it became yellow again, then red, and at length of a dark browniſh red conſiderably deeper than the other more ſaturated ſolution. On ſtanding for ſome time, it grew perfectly clear, depoſiting a paler, yellowiſh precipitate.

3. To determine whether platina was capable of preventing a ſmall proportion of gold from diſcovering itſelf on this trial, one drop of a ſolution of gold was let fall into ſeveral ounces of a ſolution of platina diluted with water. On adding ſome plates of tin, the whole became immediately of a fine purple.

Remark. It may be proper to obſerve, that in theſe kinds of experiments, plates of tin are far more eligible than the ſolutions of tin uſually employ'd: For the ſolutions fail of ſtriking a purple colour with ſolution of pure gold, unleſs certain circumſtances are obſerv'd, which are not eaſily hit upon; but tin in ſubſtance conſtantly ſucceeds, and requires no particular precaution.

Experiment 5.

As gold is reviv'd from its ſolutions by inflammable ſpirits, the metal gradually ariſing to the ſurface, in form of a bright yellow cuticle;

1. A ſolution of platina was mix'd with a large proportion of highly-rectified ſpirit of wine, and expos'd for many days to the ſun, in a wide-mouth'd glaſs, ſlightly cover'd with paper, ſo as to keep out duſt. There was no appearance of any yellow ſkin; nor any other alteration, than that the platina had begun to cryſtallize from the evaporation of the fluid.

2. A drop or two of a ſolution of gold being added to a large quantity of a mixture of ſolution of platina and ſpirit of wine, and the whole expos'd as above to the ſun; a golden film was in a few days obſerv'd upon the ſurface.

Remark. It follows from this experiment, and the foregoing one with tin, that platina contains no gold; and that it cannot, any more than the common metallic or other ſoluble ſubſtances, prevent a ſmall proportion of gold mix'd with it from being diſcoverable.

Experiment 6.

1. The ſpirits of ſal ammoniac, prepar'd both by quicklime and by fix'd alcaline ſalts, added to ſolutions of platina diluted with diſtill'd water, precipitated a fine red ſparkling powder; which, exſiccated, and expos'd to the fire in an iron ladle, became blackiſh; without at all fulminating, which calces of gold, prepar'd in the ſame manner, do violently. On waſhing ſome of this precipitate upon a filter, by repeated affuſions of water, the greateſt part of it diſſolv'd; only a ſmall quantity of a blackiſh matter remaining, and the liquor paſſing through of a deep, bright, golden colour. A very large quantity of the fluid

fluid was tinged of this colour by a ſmall one of the powder.

2. Salt of wormwood, fix'd nitre, the *lixivium ſaponarium* of the London *pharmacopœia*, precipitated a powder ſimilar to the foregoing, except that its colour was leſs brilliant.

3. Sal ammoniac likewiſe, one of the ingredients, to which the menſtruum ow'd its power of diſſolving the platina at firſt, precipitated great part of it in form of a ſimilar powder.

4. The liquors remaining after all theſe precipitations with ſaline ſubſtances, appear'd of a yellow colour, almoſt as deep as before the precipitation. Fix'd and volatile alcalies being added alternately, the liquor ſtill continu'd yellow: But either of them, added after ſal ammoniac had perform'd its office, threw down a freſh precipitate, which left the liquor colourleſs.

5. The addition of tin likewiſe, after either of the ſalts ſeparately had thrown down all they were capable of doing, occaſion'd a freſh and complete precipitation; provided a little more of the menſtruum was dropt in, to enable the liquor to act upon the metal.

Experiment 7.

As gold is totally precipitated by alcaline ſalts, but platina only in part; and as a minute portion of platina, remaining diſſolv'd, tinges a ſurpriſingly large quantity of the fluid of a yellow colour; it was preſum'd, that a ſmall admixture of platina with gold might by this means be readily diſcoverable.

A few

A few drops of a ſolution of platina were therefore mixed with above an hundred times the quantity of a ſolution of gold; the whole diluted with water; and a pure alcaline ſalt gradually added, as long as it occaſioned any efferveſcence or precipitation. The remaining liquor was of ſo deep a yellow colour, that it was judged the platina would have diſcovered itſelf, though its proportion had been leſs than one thouſandth part of that of the gold.

Experiment 8.

1. Zinc, which totally precipitates all the other known metallic bodies, put into a diluted ſolution of platina, was very quickly acted on, and threw down a blackiſh calx. The liquor in good meaſure preſerved its yellow colour; a mark, that part of the platina remained ſuſpended.

2. Iron, which precipitates all the metals from their ſolutions, except zinc, threw down a ſimilar calx. It could not be judged by the eye, whether the precipitation was complete, the ſolutions of iron and platina nearly agreeing with one another in colour.

3. Copper, the precipitant of mercury and gold, readily threw down platina from its ſolution, in form of a greyiſh calx, which was found upon trial to retain a notable quantity of the copper. The liquor remaining after the platina had fallen was of a more duſky green than ſolutions of pure copper, probably from its retaining ſome of the platina.

4. Mercury, which precipitates gold alone from aqua regia, put into a diluted ſolution of platina, ſeemed in a little time to be divided, and did not

run freely. Soon after, it appeared covered with a greyiſh matter, which at firſt was apprehended to be a precipitate, but was found afterwards to be a part of the mercury corroded. Upon applying a moderate heat, the whole of the quickſilver, the quantity of which was very conſiderable, was diſſolved, without any precipitation.

The experiment was repeated with a larger quantity of mercury than the ſolution was capable of taking up. The platina now gradually fell down among the undiſſolved quickſilver, in form of a dark browniſh powder; leaving the liquor nearly colourleſs.

5. A ſolution of gold mingled uniformly with a ſolution of platina, without occaſioning any turbidneſs or precipitation. The mixture, diluted with water, and ſuffered to ſtand for ſome time, threw up a bright golden pellicle to the ſurface.

Experiment 9.

1. A ſolution of platina, ſuper-impregnated with as much mercury as it was capable of taking up, on being evaporated a little, ſo as to diſpoſe it to ſhoot, yielded cryſtals not at all like thoſe of platina, but in form of ſpicula, externally of a yellowiſh hue. Theſe, ſlightly waſhed with proof ſpirit, became colourleſs: Expoſed to the fire, they emitted copious white fumes, with a hiſſing or crackling noiſe; and left a very ſmall quantity of a reddiſh powder.

2. A mixture of ſolutions of gold and platina, being treated in the ſame manner, ruby-coloured cryſtals were obtained, which appeared to be chiefly gold, with very little of the platina.

Remark.

Remark. It ſeems therefore, that mercury and gold cryſtallize from their ſolutions before platina, leaving greateſt part of that mineral diſſolved. This affair, particularly with regard to gold, deſerves farther inquiry.

Experiment 10.

As the calces of metals, obtained by precipitation from acids or by other means, vitrify along with fritt or glaſs, and tinge them of various colours; and as this proceſs is recommended by ſome for inveſtigating the nature of unknown metallic bodies; the following trials were made with precipitates of platina.

1. Half an ounce of a precipitate thrown down from ſolution of platina by plates of pure tin, was triturated in an iron mortar with eight times its quantity of common white glaſs, the mixture put into a crucible, which was cloſely luted, and placed in a wind furnace. The fire was gradually raiſed, and kept up extremely ſtrong for about ten hours; when, the crucible being taken out and broken, the matter appeared of a dark blackiſh colour, untranſparent, eaſily friable; interſperſed with a bright whitiſh matter, apparently metallic.

Remark. It is probable, that this metallic matter was the platina; and that the glaſs owed its opacity and dark colour, not to this mineral, but to the tin in the precipitate, ſome particles of iron abraded from the mortar, or other accidental cauſes.

2. A quarter of an ounce of a precipitate of platina, made by alcaline ſalt, was ground in a glaſs mortar with twelve times its weight of white glaſs; and committed to the ſame fire as the foregoing. The

reſult was a compact, cloudy glaſs, pretty tranſparent in thin pieces, covered in part with a thin whitiſh coat. Towards the upper part, and all round the ſides, were obſerved ſeveral particles of metal; which appeared to the eye like bright platina, and proved hard to the point of a knife.

Remark. Nor does the glaſs here ſeem to have received any thing from the platina; the change being no other than what white glaſs is found to undergo from a ſlight impregnation with inflammable matter.

General Remarks.

It appears from the experiments related in this paper, that platina, like gold, is not acted on by the ſimple acids, which diſſolve every known metallic body beſides: That aquæ regiæ, the ſolvents of gold, prove likewiſe menſtrua for platina: And that conſequently the common methods of aſſaying or purifying gold by *aqua fortis*, *aqua regis*, or the *regal cement*, can no longer be depended on: That it differs from gold, in giving no ſtain to the ſolid parts of animals, not ſtriking a purple colour with tin, not being revived from its ſolutions by inflammable ſpirits, not being totally precipitable by alcaline ſalts; that in certain circumſtances it throws out gold from its ſolutions; that theſe properties afford means of diſtinguiſhing a ſmall proportion of gold mixed with a large one of platina, or a ſmall proportion of platina with a large one of gold; and that platina contains no gold, excepting the few particles diſtinguiſhed by the eye: That platina is precipitated from its ſolutions by the vitriolic acid, and by the metallic ſubſtances, which precipitated gold, though ſcarce totally

totally by any: And that its precipitates reſiſt vitrification, and this perhaps in a more perfect manner than precipitates of gold itſelf.

PAPER III.

Read June 27, 1754. THE two former papers have given an account of the *habitus* or relation of platina to the principal ſubſtances, which act upon metallic bodies; and ſhewn, that it is a ſimple metal, of a particular kind, eſſentially diſtinct from all thoſe hitherto known, though poſſeſſed of ſome properties generally ſuppoſed peculiar to gold. Many of its diſtinguiſhing characters have been already pointed out: Others will reſult from combining it with the ſeveral metals; with each of which, notwithſtanding its reſiſtance to the moſt intenſe fires by itſelf, or with unmetallic additions, it melts perfectly; occaſioning remarkable alterations in their colour, texture, and hardneſs.

ARTICLE I.

Platina *with* Tin.

1. *Equal parts* of platina and pure tin were injected into a mixture of black flux and common ſalt in ſtrong fuſion; and urged with a quick fire, in a good blaſt furnace. After a few minutes the whole appeared perfectly melted; and on being inſtantly poured out, run freely along a narrow mould, forming a ſmooth ingot, nearly of the ſame weight with the platina and tin employed. The compound proved extremely brittle, breaking eaſily from a fall: Inter-

Internally it appeared of a cloſe and ſmooth, though uneven ſurface; and of a dark-grey colour. By the file, or a knife, it was readily ſcraped into a blackiſh duſt.

2. *One* part of platina and *two* of tin, covered with black flux, borax and common ſalt, were melted in a wind furnace: The platina appeared perfectly taken up by the tin, ſoon after the fire had been raiſed to a light white heat. The ingot was found deficient in weight about one-ninetieth. It greatly reſembled the foregoing, being only a little leſs brittle, and of a ſomewhat lighter colour.

3. *One* ounce of platina and *four* of tin, covered with black flux and common ſalt, and urged with a quick fire, melted together without loſs. This compound yielded a little to gentle ſtrokes of a flat hammer, but was by no means tough. It broke in pieces from a rude blow, and was ſtill readily ſcraped into duſt by a knife. The ſurface of the fracture was rough and granulated.

4. *One* part of platina and *eight* of tin, injected into a fluid mixture of black flux and common ſalt, united, without loſs, into a pretty tough compound; which bore to be conſiderably flattened under the hammer without breaking, cut ſmooth with a thin chiſſel, and ſhaved with a knife. Broken, it appeared of a ſparkling, dark-coloured, coarſe-grained texture.

5. *One* part of platina and *twelve* of tin, treated in the ſame manner, formed a mixture tolerably ductile; but ſtill of a dull, dark hue, and a rough coarſe grain, though ſomewhat leſs ſo than the preceding.

6. A mixture of *one* part of platina and *twenty-four* of tin, proved not much ſtiffer than tin. The colour

colour was whiter, and the grain finer and evener, than thoſe of the preceding compoſitions; though in both reſpects it fell conſiderably ſhort of pure tin.

7. Several of theſe compoſitions, covered with black flux, which had been previouſly melted, were expoſed, in crucibles cloſely luted, to a ſtrong fire in a wind furnace, which was ſteadily kept up for eight hours. When taken out, they were all found to have ſuffered ſome diminution, amounting to about one-fortieth of the tin. In appearance and quality, there was no ſenſible alteration, except that the mixture ſeemed more uniform, and the grain a little finer.

8. The remarkable gravity of platina induced us to examine the ſeveral mixtures hydroſtatically. Here it was found, that the ſpecific weight of the compound conſtantly turned out leſs than the medium of the gravities of the two ingredients; and generally the more ſo, as the proportion of the platina was the greater.

	Specific Gravity.				
	By Experiment.		By Calculation.		Difference.
Platina ——	17.	000			
Platina 1, Tin 1	10.	827	12.	090	1. 263
Platina 1, Tin 2	8.	972	10.	453	1. 481
Platina 1, Tin 4	7.	794	9.	144	1. 350
Platina 1, Tin 8	7.	705	8.	271	0. 566
Platina 1, Tin 12	7.	613	7.	935	0. 322
Platina 1, Tin 24	7.	471	7.	573	0. 102
Tin ——	7.	180			

Remarks. It appears from the foregoing experiments, that platina melts with at leaſt equal its weight of tin: That it deſtroys the malleability of near

near four times its weight: That with larger proportions it forms compounds tolerably ductile, but renders the texture of the tin coarſer, and debaſes its colour. The difference in colour of theſe compoſitions was much leſs conſpicuous on the touchſtone, than when the fractures of the ingots were examined; though, on cloſe inſpection, they appeared all ſenſibly duller and darker than pure tin, and the more ſo, in proportion as the platina prevailed. They all tarniſhed in the air; thoſe leaſt, which had a very ſmall or a very large proportion of platina.

It is remarkable, that though tin is a metal very readily deſtructible by fire, yet in moſt of the preceding fuſions, there was ſcarce any ſenſible loſs of weight. This is to be attributed not ſolely to the admixture of the platina, but likewiſe to the flux made uſe of, and more particularly to the celerity and ſhort continuance of the heat. In N° 2 and 7, the only ones, in which the loſs was at all conſiderable, the fire was ſlowly raiſed, and long continued.

ARTICLE 2.

Platina *with* Lead.

1. *Equal parts* of platina and lead were injected into a mixture of black flux and common ſalt, previouſly melted together; and the fire haſtily raiſed by bellows. A much ſtronger heat was requiſite than for the fuſion of platina with an equal quantity of tin; and the loſs was conſiderably greater, amounting to about one-ſixty-fourth. The metal yielded difficultly to the file; broke, from a moderate blow, of a cloſe texture, uneven ſurface, and rough jagged edges:

edges: The colour was very dark, with a faint purpliſh caſt.

2. *One* part of platina and *two* of lead, covered with borax and black flux, and expoſed to a gradual fire, in a wind furnace, did not come into fuſion till the fire had been raiſed to a ſtrong white heat: From the continuance of heat in this experiment the loſs was great, being nearly one-twenty-fourth of the mixture. The ingot proved hard and brittle, like the preceding, but broke off a ſtriated ſurface.

3. *One* ounce of platina and *three* of lead, treated in the ſame manner, required ſtill a very ſtrong fire for their perfect fuſion; and loſt about one-twenty-ſixth. The metal broke leſs eaſily than either of the preceding, and in ſome meaſure yielded to the hammer: The colour was ſomewhat darker, and inclined more to purpliſh.

4. *One* part of platina and *four* of lead, being covered with black flux and common ſalt, and committed to a wind furnace, the platina was not perfectly taken up, till the fire had been raiſed to a conſiderably ſtrong white heat: The loſs was one-fortieth. The ſame proportions of the metals, injected into a fluid mixture of the flux and ſalt, previouſly brought to the above degree of heat, almoſt inſtantly melted, and loſt only one-hundred-and-ſixtieth. The ingot was much tougher than of the foregoing, filed well, and cut tolerably ſmooth with a knife. Upon breaking, the upper part appeared compoſed of bright plates, the lower of dark purpliſh grains.

5. *One* part of platina and *eight* of lead united eaſily in a quick fire, and loſt little or nothing. The metal worked and looked like very bad lead: On

breaking, the texture appeared partly compoſed of tranſverſe fibres, and partly of grains; the colour dull and purpliſh.

6. *One* part of platina and *twelve* of lead united, without loſs, into a compound very little different from the foregoing. On breaking, its texture was ſomewhat finer, and compoſed chiefly of fibres, with very few grains.

7. A mixture of *one* part of platina and *twenty-four* of lead proved not very much harder than lead of a middling quality. The colour was ſtill ſomewhat purpliſh, and the texture fibrous; but the fibres were remarkably finer than where the platina was in larger proportion.

8. The foregoing compoſitions, when newly poliſhed, appeared in general of a dark iron colour; which, upon expoſure to the air, quickly tarniſhed to a browniſh yellow, a deep purpliſh, and at length a blackiſh. They all filed freely, without ſticking in the teeth of the file, as lead does by itſelf.

9. Upon returning theſe compounds to the fire a ſecond time, it was conſtantly obſerved, that after they had come into perfect fuſion, if the heat was ſlackened a little, great part of the platina ſubſided: That nevertheleſs, the lead decanted off, even in a heat below ignition, retained ſo much of the platina, as rendered it of a fine fibrous texture, and purpliſh colour.

The ſeveral mixtures, covered with black flux, and kept in ſtrong fuſion, in crucibles cloſely luted, for eight hours, ſuffered a diminution in weight, amounting to about one-thirtieth of the lead. On breaking, thoſe with a large proportion of platina appeared

peared of a leafy, and thoſe with a ſmaller, of a fine fibrous texture, which ſeemed in general to be characteriſtics of the perfect union of the platina and lead. They all looked whiter and brighter than at at firſt, but tarniſhed ſooner in the air. One mixture in particular, of four ounces of platina and twelve of lead, broke into large, white, bright, ſhining, talc-like flakes; which, on expoſure to the air, changed in a little time to a reddiſh, a purple, and a deep blue; and at length turned ſlowly to a dark blackiſh colour.

10. On examining theſe compounds hydroſtatically, their gravities turned out leſs than they ought to have been according to their calculation, but not ſo much leſs as thoſe of the compoſitions of platina and tin.

	Specific Gravity.		
	By Experiment.	By Calculation.	Difference.
Platina ——	17. 000		
Platina 1, Lead 1	14. 029	14. 193	0. 164
Platina 1, Lead 2	12. 925	13. 257	0. 332
Platina 1, Lead 4	12. 404	12. 509	0. 105
Platina 1, Lead 8	11. 947	12. 009	0. 062
Platina 1, Lead 12	11. 774	11. 818	0. 044
Platina 1, Lead 24	11. 575	11. 610	0. 035
Lead ——	11. 386		

Remark. It appears, that a ſmall proportion of platina is taken up and kept ſuſpended by lead, in a very gentle heat; but that a large proportion is not taken up near ſo eaſily as by tin, and if united by a ſtrong fire, ſubſides in part upon its abatement. A little quantity ſtiffens and hardens lead more than it

does tin; but a large one does not near ſo much diminiſh its malleability. A leafy or fibrous texture, a purpliſh colour or diſpoſition to acquire this colour in the air, are peculiar to the mixtures with lead.

ARTICLE 3.

Platina *with* Silver.

1. *Equal parts* of platina and of pure ſilver revived from *luna cornea*, covered with borax, and urged with a ſtrong fire in a blaſt furnace, melted perfectly together, and without loſs, but did not run freely along the mould. The ingot was hard to the file, and broke from a rude blow; though by gentle ſtrokes it bore to be conſiderably flattened. Internally it appeared of a much duller and darker colour than ſilver, and of a coarſer texture.

2. *One* part of platina and *two* of ſilver, covered with nitre and common ſalt, did not flow thin till the fire was raiſed to a very ſtrong white heat. The compound proved leſs brittle than the foregoing, and not ſo hard to the file: The texture was compoſed of ſmaller grains, and the colour whiter.

3. *One* part of platina and *three* of ſilver ſtill required a very ſtrong fire for their perfect fuſion: The metal was hard and brittle, though leſs ſo than the preceding: When well and repeatedly nealed, it bore to be hammered, or flattened betwixt ſteel rollers, into thin plates.

4. *One* part of platina and *ſeven* of ſilver melted together with eaſe. This compound hammered tolerably well, proved much harder than ſilver, and not ſo white, or of ſo fine a grain.

5. Theſe

5. Theſe compoſitions, weighed hydroſtatically, turned out like the others, a little lighter than by calculation: But the difference, which before ſeemed to increaſe with the platina, was here greateſt when the platina was in leaſt proportion.

	Specific Gravity.		
	By Experiment.	By Calculation.	Difference.
Platina ——	17. 000		
Platina 1, Silver 1	13. 535	13. 990	0. 455
Platina 1, Silver 2	12. 452	12. 987	0. 535
Platina 1, Silver 3	11. 790	12. 485	0. 695
Platina 1, Silver 7	10. 867	11. 732	0. 865
Silver ——	10. 980		

Remark. Platina appears to unite more difficultly with ſilver than with either of the foregoing metals. Even when the proportion of the platina is ſmall, the greateſt part of it ſubſides upon an abatement of the heat, by which the union had been effected. This was prevented by pouring out the metal, when perfectly fluid, at one jet, into a broad mould; in which the compound begun to congeal before the platina could ſeparate.

Platina diminiſhes the malleability of ſilver far leſs than that of tin or lead; and does not, in whatever proportion employed, ſo much debaſe its colour, or diſpoſe it to tarniſh in the air.

ARTICLE 4.

Platina *with* Gold.

1. *Equal parts* of platina and gold, expoſed to an intenſe fire, melted perfectly together, and ran thin

thin into a long mould, without loſs. The metal was of a white colour, hard to the file, broke from a rude blow, but when well nealed, yielded conſiderably to the hammer.

2. *One* part of platina and *four* of gold came into fuſion in a moderate fire, but ſtill required a very ſtrong one for their perfect union. This compound appeared but a little paler than ſtandard gold with *ſilver alloy*; and proved ſo tough, as to be beat, with proper care, into thin plates, without breaking or cracking about the edges. On melting it a ſecond time with nitre and borax, it became very pale, and was not without great difficulty made to recover its colour.

ARTICLE 5.

Platina *with* Copper.

1. *Equal parts* of platina and copper, expoſed, without addition, to a ſtrong fire haſtily excited by bellows, ſoon became fluid, but not thin; and loſt about one-ſixty-fourth. The metal proved extremely hard to the file; broke difficultly on the anvil; flew aſunder on endeavouring to cut it with a chiſſel; and appeared internally of a coarſe-grained texture and white colour.

2. *One* ounce of platina and *two* of copper, urged with a quick fire in a blaſt furnace, without addition, flowed ſufficiently thin, and ſcarce ſuffered any ſenſible loſs. The metal was ſtill very hard, and yielded but little to the hammer. It looked darker coloured than the foregoing, with a ſlight reddiſh caſt.

3. *One* ounce of platina and *four* of copper, treated in the ſame manner, united, without loſs, into a pretty

pretty tough compound; which bore to be conſiderably flattened, cut with a chiſſel, and bent almoſt double before it cracked. Internally, it looked of a fine texture, and a very pale copper colour.

4. A mixture of *one* ounce of platina and *five* of copper, ſtretched ſomewhat more eaſily under the hammer than the preceding; and appeared of a redder colour.

5. Upon increaſing the copper to *eight* times the quantity of the platina, the compound proved ſufficiently tough, broke difficultly, and hammered well. It was much harder than copper, and of a paler colour.

6. A mixture of *one* part of platina and *twelve* of copper was ſomewhat more eaſily extended under the hammer than the foregoing, and proved ſofter to the file. It ſtuck a little in the teeth of the file, which the compoſitions with a larger proportion of platina did not.

7. A mixture of *one* part of platina and *twenty-five* of copper was ſtill a little paler coloured than pure copper, and conſiderably harder and ſtiffer, though very malleable. Upon increaſing the copper a little farther, the mixture retained a degree of hardneſs, and appeared of a fine roſe colour.

8. Upon weighing the foregoing compoſitions hydroſtatically, the diminution of gravity was found more regular than in the mixtures with other metals, being conſtantly greater in proportion as the quantity of platina was larger.

	Specific Gravity. By Experiment.	By Calculation.	Difference.
Platina ——	17. 000		
Platina 1, Copper 1	11. 400	12. 915	1. 515
Platina 1, Copper 2	10. 410	11. 553	1. 143
Platina 1, Copper 4	9. 908	10. 464	0. 556
Platina 1, Copper 5	9. 693	10. 191	0. 498
Platina 1, Copper 8	9. 300	9. 738	0. 438
Platina 1, Copper 12	9. 251	9. 458	0. 207
Platina 1, Copper 25	8. 970	9. 144	0. 174
Copper ——	8. 830		

Remark. In the foregoing fuſions, though in general no flux was made uſe of, there was ſcarce any ſenſible loſs of weight, unleſs in N° 1, where the large proportion of platina required the fire to be raiſed to a violent degree. This ſeems owing, in good meaſure, to the platina preventing the ſcorification of the copper: For upon melting pure copper a great number of times, both with and without fluxes, there was conſtantly a little loſs.

A ſmall proportion of platina appears to improve the hardneſs of copper, without injuring its colour, or, ſo far as could be judged, its malleability. The mixtures with a large proportion of platina are difficultly extended under the hammer when cold; and whilſt red hot, fly in pieces. They all bear a good poliſh, and do not tarniſh in the air ſo much, or ſo ſoon, as pure copper.

ARTICLE 6.

Platina *with* Iron.

Iron, the laſt of the metals in point of fuſibility, was ſeveral times attempted to be united with platina, in

in its perfect malleable ſtate. But as the fluxes neceſſary for rendering forged iron fuſible corroded the crucibles before the metal flowed thin enough to diſſolve the platina, pure caſt iron was ſubſtituted.

1. Caſt iron and platina, *of each* three ounces, expoſed without addition to a ſtrong fire, united into a thick fluid; which, on adding an ounce more of iron, flowed thin. The compound ſuffered to cool in the crucible (which had become too ſoft from the heat to admit of its being poured out) was found, on breaking the veſſel, in one lump, not convex, the form, which the iron uſually aſſumes, but of a very concave ſurface: The weight about one-ſixtieth leſs than that of the metals employed. It proved exceſſively hard, ſo as not to be touched by the file; and ſo tough, as not to be broke by repeated blows of a ſledge-hammer, from which it received ſome impreſſion. Heated red, it broke eaſily, and looked internally of an uniform texture, compoſed not of bright plates like the iron at firſt, but of very dark-coloured grains.

2. *One* ounce of platina being injected upon *four* of caſt iron beginning to melt, and the fire kept up ſtrong, the whole came quickly into fuſion, and on cooling, formed an equable compound, which like the former proved extremely hard, and ſeemed to ſtretch a little under the great hammer without breaking. The colour was ſtill very dark, though leſs ſo than when the platina was in larger proportion.

3. *One* part of platina and *twelve* of iron melted without difficulty, and with little or no loſs. This compound was ſtill much harder than the iron at firſt, and had a very conſiderable degree of tough-

neſs. Like the others, it could not be broke whilſt cold, without extreme violence; but proved very brittle when heated red.

4. The foregoing compoſitions, eſpecially thoſe in which the proportion of platina was large, received a fine poliſh; and did not ruſt or tarniſh on being expoſed to the air in a dry room for ſeveral months.

5. A compoſition of one part of platina and four of iron was treated with ſubſtances, which produce notable alterations in pure iron. Surrounded with Reaumur's ſteel-making mixture (compoſed of charcoal-powder, ſoot, wood-aſhes, and common ſalt), and cemented in a cloſe luted crucible for twelve hours, it gained an increaſe of one-thirty-ninth its weight, yielded to the file more eaſily than at firſt, ſeemed to receive no additional hardneſs on being ignited and quenched in water, and diſcovered none of the qualities of ſteel. A piece broke off from the ſame ingot, treated in the ſame manner, with the powder for ſoftening caſt iron (*viz.* bone-aſh, with a ſmall proportion of charcoal), was found increaſed in weight about one-thirty-fourth, proved leſs hard to the file than at firſt, but manifeſtly harder than the part cemented with the ſteel-making mixture.

	Specific Gravity. By Experiment.		By Calculation.		Difference.
Platina —	17.	000			
Platina 3, Iron 4	9.	917	11.	343	1. 426
Platina 3, Iron 12	8.	700	9.	080	0. 380
Platina 3, Iron 16	8.	202	8.	663	0. 461
Platina 3, Iron 36	7.	800	7.	862	0. 062
Iron —	7.	100			

General

General Remarks.

Platina melts with equal its weight of each of the metals; with one more readily than with another. With ſome it becomes fluid, if the proportion of the platina is not large, in a moderate fire; but a ſtrong one is conſtantly requiſite for its perfect ſolution. Compoſitions of ſilver, copper, lead, with about one-third their weight of platina, which had flowed thin enough to run freely into the mould, and appeared to the eye perfectly mixed, on being digeſted in aqua fortis till the menſtruum ceaſed to act, left ſeveral grains of platina in their original form. Upon viewing theſe with a microſcope, ſome appeared to have ſuffered no alteration; others exhibited an infinite number of minute bright globular protuberances, as if they had juſt begun to melt.

Platina hardens and ſtiffens all the metals; one more than another, lead the moſt. In a moderate quantity it diminiſhes, and in a large one deſtroys, the toughneſs of all the malleable metals; but communicates ſome degree of this quality to caſt iron. Tin bears much the leaſt, and gold and ſilver the greateſt quantity, without the loſs of their malleability.

A very ſmall proportion of platina ſcarce injures the colour of copper and gold: A larger renders both pale: A far leſs quantity has this effect upon copper than on gold. It debaſes and darkens, in proportion to its quantity, the colour of the white metals; that of ſilver much the leaſt, and of lead the moſt. It in good meaſure preſerves iron and copper from tarniſhing in the air; ſcarce alters gold or ſilver in this reſpect; makes tin tarniſh ſoon, and lead exceeding quickly.

PAPER IV.

Platina *mixed with* Semi-metals.

1. *With* Mercury.

Read July 4, 1754.

1. AN ounce of platina and ſix ounces of pure quickſilver were rubbed together, with a little common ſalt and water, and a few drops of ſpirit of ſalt, in an iron mortar. After ſome hours trituration, the grains of platina became coated with the quickſilver, ſo as to cohere into an imperfect amalgam. A part of the fluid quickſilver, poured off, and evaporated in an iron ladle, left a conſiderable quantity of a dark-coloured powder, intermingled with bright ſhining moleculæ: A part ſtrained through leather, left a ſmaller proportion of a ſimilar powder.

The platina, which had been thus attenuated by the mercury, ſo as to paſs with it through the pores of leather, proved as refractory in the fire as at firſt. Expoſed to a very vehement heat, by itſelf, with borax, with white glaſs, it neither melted, or ſuffered any ſenſible alteration; nor did it communicate any colour to either of the fluxes.

2. One part of platina and about four of lead were melted perfectly together; and after the heat had ſomewhat abated, poured gently into three times the quantity of quickſilver, heated ſo as to fume. A blackiſh powder was immediately thrown to the ſurface: This appeared to be chiefly platina. On grinding them together, a freſh powder gradually ſeparated; which, being occaſionally waſhed off, in appearance

pearance greatly reſembled the foregoing, but was found, on proper trials, to participate much more largely of the mercury and lead than of platina. The amalgam, which was of a very dull colour, on expoſure to the fire ſwelled and leapt about, though the heat was ſcarce ſufficient to evaporate the quickſilver. After conſtant and rapid agitation with water, occaſionally renewed, in an iron mill, for a week, it looked bright and uniform, and ſuffered the mercury to exhale freely. A dark-coloured calx remained, which proved, upon examination, to be platina, with a very little lead.

Remark. Mercury is ſuppoſed to have a greater affinity with lead than any other metallic body, gold and ſilver excepted. In this experiment, it had a greater affinity with platina than with lead, ſince it retained moſt of the platina, after the lead, which was in much larger proportion, had been almoſt intirely thrown out. The part of the platina, which the mercury rejected at firſt, and that which it retained to the laſt, did not appear diſſimilar to one another, or different in quality from the platina employed.

3. A mixture of one part of platina and two of gold, which proved very white and brittle, after being repeatedly nealed, was cautiouſly flattened into thin plates, and thrown red-hot into boiling quickſilver. On trituration and ablution with water, a powder ſeparated, copiouſly at firſt, and by degrees more ſparingly. After the proceſs had been continued about twenty-four hours, there was no farther ſeparation, except of a very little blackiſh matter, into which a part of the mercury is always changed in theſe kinds

kinds of operations. The amalgam, which looked very bright, left, upon evaporation, a ſpongy maſs, of a high colour, which being melted, and poured into an ingot, proved very ſoft, extremely malleable, and in all reſpects reſembled the pure gold made uſe of, without the leaſt appearance of platina.

Remark. It is greatly to be wiſhed, that this method of purifying gold from platina may prove ſufficiently accurate to exactly determine the quantity of each in the mixt. The experiments hitherto made do not ſufficiently clear up this point; a great number are ſtill neceſſary before it can be fully aſcertained.

2. *With* Biſmuth.

Equal parts of platina and biſmuth, injected into a mixture of black flux and common ſalt, previouſly brought into fuſion, and urged with a quick fire, ſtrongly excited by bellows, melted perfectly in a few minutes, and ſuffered very little loſs. Without theſe precautions, the biſmuth could ſcarce be made to take up above one-third its weight; great part of which, on an abatement of the heat, ſubſided.

Mixtures of platina with different proportions of biſmuth proved all, like the biſmuth itſelf, extremely brittle: One was not remarkably more ſo than another. To the file, they were ſcarce harder than pure biſmuth. They broke of an irregular ſurface, compoſed chiefly of ſtriæ, with ſome plates. When newly broken, they looked bright and ſparkling; except the compoſitions with a large proportion of platina, which were of a dull greyiſh colour, without any brightneſs. They all tarniſhed ſlowly in the air,

air, to a dark yellowiſh, purpliſh or bluiſh colour: Several acquired in part a fine deep blue, which has ſuffered no change in above a twelve-month; ſome parts of the maſſes ſtill remaining white as at firſt, and others inclining to purple.

3. *With* Zinc.

Upon an ounce of platina, covered with borax, and heated in a blaſt furnace to a ſtrong white heat, was injected an equal quantity of zinc. A violent deflagration aroſe, and the platina was almoſt inſtantly diſſolved: The matter, immediately poured out, was found to have loſt near half an ounce.

Upon ſeveral times repeating this experiment with different proportions of the two metals, both in a quick fire, and in one more gradually raiſed in a wind furnace, the zinc was conſtantly found a powerful menſtruum for platina, but ſuffered great loſs from the heat requiſite for rendering the mixture ſufficiently fluid. When ſo much of the zinc had been diſſipated, that the remainder amounted to no more than one-fourth of the platina, the compound ſtill continued fluid enough to run freely into a long mould.

Compoſitions of platina and zinc differed little in appearance from zinc itſelf; except that where the quantity of platina was large, they were of a cloſer texture, and a duller hue, with rather more of a bluiſh caſt. They did not tarniſh, or change their colour, on being expoſed for ſeveral months to the air, in a dry room. They were harder to the file than the zinc at firſt, and fell in pieces under the hammer;

hammer, without at all ſtretching; which pure zinc does in a conſiderable degree.

4. *With* Regulus of Antimony.

Regulus of antimony, the moſt difficultly fuſible of the ſemi-metals, diſſolved, in a ſtrong fire, equal its weight of platina. The compound looked of a much duller colour than the regulus at firſt; and broke of a cloſe and uniform, though uneven, ſurface. It proved conſiderably harder to the file, but not remarkably more or leſs brittle.

On increaſing the quantity of the regulus, the compound proved brighter, and of a leafy texture, little different from that of the pure regulus.

Platina *mixed with* Compound Metals.

1. *With* Braſs.

1. Equal parts of platina and braſs, covered with borax, and urged with a quick fire in a blaſt furnace, melted perfectly together, and ſcarce ſuffered any loſs. The mixt was of a greyiſh white colour, filed hard like bell-metal, broke from a blow of the hammer, without ſtretching or receiving any impreſſion, and flew aſunder on endeavouring to cut it with a chiſſel. Internally, it appeared of an uniform fine grain, a cloſe texture, and a darker colour than on the outſide. It bore a very fine poliſh, and did not tarniſh on being expoſed to the air in a dry room for many months.

2. One part of platina and two of braſs, melted in a ſlow fire, loſt about one-thirty-ſixth. The ingot was of a duller colour than the foregoing, with a faint

a faint yellowiſh caſt: It filed ſofter, broke leſs readily from the chiſſel, but cracked and fell in pieces under the hammer.

3. One part of platina and four of braſs, covered as before with borax, and expoſed to a quick fire, melted without loſs. This compound proved yellower than the preceding, filed ſofter, bore to be cut ſome depth with a chiſſel before it broke, and received ſome impreſſion from the hammer, ſtretching a little, but ſoon cracking in various directions.

4. Upon increaſing the braſs to ſix times the weight of the platina, the compound appeared yellower, though ſtill very pale. It proved ſofter to the file; and received a greater impreſſion from the hammer, and a deeper one from the chiſſel, before it broke.

5. A mixture of one part of platina and twelve of braſs was conſiderably paler, and much harder, than braſs. It broke from the chiſſel; and cracked, before it had extended much, under the hammer. It bore a good poliſh, and was leſs apt to tarniſh than braſs; though in both reſpects it fell ſhort of the compoſitions with larger proportions of platina.

2. *With* Copper *and* Tin.

1. One hundred parts of platina, thirty-four of copper, and twelve of tin, covered with borax, became fluid in a ſtrong fire, and ſuffered no conſiderable loſs. The ingot proved extremely hard, ſo as ſcarce to be touched by the file; and very brittle, breaking from a moderate blow, of a rough ſurface, and dull bell-metal colour. It bore a good poliſh, and did not tarniſh in the air.

2. Platina and copper, of each one ounce, and four ounces of tin, melted perfectly together, and without loſs. This compound filed freely and eaſily, bore to be cut with a knife, but broke readily on the anvil, of an irregular ſurface, and dull whitiſh colour. Poliſhed, it looked like poliſhed iron. The fracture ſoon tarniſhed to a yellow; the poliſhed part grew dull, but retained its colour.

3. A mixture of platina and copper, of each one part, and eight of tin, proved ſofter than the foregoing; and bore to be flattened a little under the hammer. It broke of a very irregular ſurface, compoſed of a great number of bright white plates. The fracture ſoon tarniſhed; the poliſhed part retained its colour.

Remark. It is obſervable, that in the firſt of theſe experiments, platina was perfectly taken up by leſs than half its weight of a mixture of copper and tin; though it could ſcarce be made to melt with leſs than its own weight of either of them ſeparately, in a fire equally, or rather more, intenſe.

The ſpecific gravity of theſe mixtures turned out, upon experiment, a little leſs than by calculation; though the copper and tin, melted together without platina, formed a compound ſpecifically heavier than even the copper by itſelf.

The ſeveral mixtures with zinc, biſmuth, regulus of antimony and braſs, were likewiſe weighed hydroſtatically, and found all ſomewhat lighter than they ought to have been by calculation. As few hydroſtatical experiments ſeem to have been made upon zinc and biſmuth, it may be proper to mention, that

that the gravity of pure zinc turned out 7. 050, and that of biſmuth 9. 733.

Hitherto we have conſidered the miſcibility of platina with metallic bodies, and the alterations, which different proportions of it produce in their appearance and qualities: employing the neceſſary precautions for preventing the ſcorification and diſſipation, which moſt of the metals ſuffer in the fire; and which ſome remarkably promote in thoſe, which by themſelves are more difficultly, or not at all, deſtructible. We ſhall now examine the relation of platina, in this reſpect, to thoſe metallic ſubſtances, which are the moſt deſtructive.

1. *Cupellation and Scorification of* Lead *with* Platina.

1. A mixture of platina and lead was cupelled, under a muffle, in an aſſay-furnace. For ſome time the proceſs went on well; the lead gradually changing into ſcoriæ, which were thrown of to the ſides, and abſorbed by the cupel, or diſſipated in fume. In proportion as the lead worked off, the matter required a ſtronger fire to keep it fluid; and at length, collecting into a dull flat lump, could no longer be made to flow in the greateſt degree of heat, which the furnace was capable of giving. The lump broke very eaſily, appeared of a dull grey colour both internally and externally, and of a porous texture. It weighed about one-fifth more than the quantity of platina employed.

2. This experiment was many times repeated and varied: the lead attempted to be worked off on bone-aſh, preſſed into the bottoms of crucibles, ſco-

rified in aſſay-crucibles, by intenſe fires, in a blaſt furnace, and blown off on teſts before the noſe of a bellows, with the ſame event; the platina not only perfectly reſiſting the power of lead, which by theſe operations deſtroys every other known metallic body, except gold and ſilver, but likewiſe retaining and preventing the ſcorification of a part of the lead itſelf.

3. In the hiſtory of the fuſion of platina with lead, it has been obſerved, that this metal depoſites in a gentle heat great part of the platina, which had been united with it by a ſtrong one. As the part, which remained ſuſpended, might be preſumed to differ from that, which ſubſided; a quantity of lead was decanted off from freſh parcels of platina, and both the decanted metal and the reſiduum ſubmitted to the preceding operations ſeparately. The event was ſtill the ſame; the matter becoming conſiſtent, when the lead had been worked off to a certain point, and refuſing farther ſcorification.

4. A mixture of platina and lead, which had been cupelled in an aſſay-furnace as long as it could be kept fluid, was expoſed in a crucible to a fire vehemently excited, by itſelf, with powdered charcoal, with black flux, borax, nitre, common ſalt. The matter neither melted, or ſuffered any conſiderable alteration, becoming only ſomewhat more porous; probably from a little of the lead having exſuded without the liquefaction of the maſs. The immediate contact of burning fuel, agitated by bellows, made ſome of theſe mixtures flow, after they had refuſed to melt in veſſels acted upon by intenſe fires. Very little of the lead was diſſipated by this means.

5. Upon

5. Upon examining the cupelled matters hydroſtatically, thoſe, which appeared moſt ſpongy, were found nearly as ponderous as the crude platina. Among the more compact, the gravity of one turned out 19.083; of another 19.136, and of a third 19.240.

Remark. It appears from theſe experiments, that platina, like gold and ſilver, is intirely indeſtructible by lead; that probably the purer grains, or fragments, have ſome heterogeneous admixtures, which are ſeparated in theſe operations; and that, perfectly pure, it is more ponderous than gold, ſince, when mixed with a conſiderable proportion of a lighter metal, it fell very little ſhort of the gravity of pure gold. There is no reaſon to ſuſpect any increaſe of its ſpecific gravity from the mixture; ſince in all the compoſitions with platina hitherto examined, there was conſtantly a diminution of the ſpecific gravity; whether the proportion of the platina was large or ſmall, the matter melted with a quick fire, or kept in fuſion for many hours.

6. A mixture of one part of platina and three of gold was cupelled with lead, under a muffle. The matter drove well for a conſiderable time; at length collected into a bright hemiſpherical lump, which by degrees became flatter, dull, and rough. The button, on being weighed, was found to retain a conſiderable portion of lead.

The experiment being repeated with a mixture of one part of platina and ſix of gold, ſome part of the lead was ſtill retained. The bead proved rounder and brighter than the foregoing, and of a good golden colour on the outſide: It broke eaſily under the hammer, and appeared internally greyiſh: Some of the fragments

fragments hung together by the outward golden coat.

7. Mixtures of platina and ſilver, ſubmitted to cupellation, retained likewiſe a conſiderable quantity of the lead. Theſe, in becoming conſiſtent, formed, not an hemiſpherical bead, but a flat maſs, very rough, and brittle, and of a dull grey colour both internally and externally.

2. *Cupellation and Scorification of* Biſmuth *with* Platina.

Mixtures of platina with biſmuth, a metallic ſubſtance, in ſome reſpects more active than lead, were cupelled under a muffle, ſcorified in aſſay-crucibles, teſted before the noſe of a bellows. In numerous repetitions of theſe experiments, the event was the ſame, as when lead was made uſe of. The mixtures, which at firſt flowed eaſily, became leſs and leſs fuſible, in proportion as the biſmuth was driven off; and at length could not be kept fluid in an intenſe white heat, though they appeared, on weighing, to retain a conſiderable proportion of the biſmuth. Nor could this ſemi-metal, any more than lead, be intirely ſeparated, by cupellation, from mixtures of platina with either gold or ſilver.

Platina cupelled with biſmuth, differed little in appearance from that, which had been treated in the ſame manner with lead. The button was more ſpongy, and ſpecifically lighter.

3. *Diffiation of* Regulus of Antimony *with* Platina.

A mixture of platina and regulus of antimony was melted, by a ſtrong fire, in a ſhallow wide crucible, and

and the noſe of a bellows directed obliquely upon the ſurface. The matter continued to flow, and fume copiouſly, for ſome hours; at length became conſiſtent in an intenſe white heat, and ſcarce emitted any more fumes, though ſtrongly blown on. The maſs, when grown cold, broke eaſily, appeared very porous, blebby, of a dull grey colour, and weighed conſiderably more than the quantity of platina employed.

Platina was likewiſe treated with crude antimony; and the regulus, obtained from this mixture, difflated as the foregoing, with the ſame event; the platina not only reſiſting the antimonial ſemi-metal, but likewiſe defending a part of it from the action of the fire and air, and refuſing to melt, after a certain quantity had been diſſipated.

4. *Deflagration of* Zinc *with* Platina.

A mixture of platina and zinc, expoſed to a ſtrong fire, deflagrated, and appeared in violent agitation. This continued but a little time; the matter quickly became ſolid, and could no longer be made to flow; or the zinc, of which a conſiderable proportion remained in it, to flame. The maſs was very brittle, dull-coloured, ſpongy, and of no ſpecific gravity.

General Remarks.

This extraordinary mineral, on which the moſt active fluxes, aſſiſted by the moſt intenſe fires, have no effect, melts perfectly with all the known metallic bodies; unleſs arſenic, a ſubſtance impatient of a degree of heat ſufficient to render itſelf fluid, is an exception. All the metals take up equal their own weight;

weight; ſome metallic compoſitions more than twice their weight.

Platina appears in general to have no remarkable affinity with one metal more than with another. Lead and iron, which do not mingle together, and of which the former will take up ſome bodies from the latter, and the latter ſome from the former, ſeem both indifferent to platina; which, if combined with either, is not ſeparated by the other.

Nevertheleſs ſome ſubſtances have greater or leſs degrees of affinity with platina than with other metallic bodies. Thus, from aqua regia, in certain circumſtances, it throws out gold; and is itſelf precipitated by the other metals, which diſſolve in that menſtruum. From quickſilver it throws out lead; and is itſelf thrown out by gold.

The changes, which platina occaſions in the perfect metals, were examined in a former paper: Its effects on the ſemi-metals are leſs remarkable. The principal are, that it increaſes the hardneſs of zinc, and the antimonial ſemi-metal, but not of biſmuth; and diſpoſes this laſt to change its colour in the air, but not the others.

Its effects on the compound metals are ſimilar to thoſe, which it produces on the ſimple ones. Braſs it renders white, hard, brittle, ſuſceptible of a fine poliſh, and not liable to tarniſh in the air, as it does the copper, and in ſome degree the zinc, of which this metal is compoſed. Mixtures of it with copper and tin are more apt to tarniſh than with copper only, and leſs than with tin only.

All metallic ſubſtances, except gold, are exeded from platina by the ſimple acids: Mercury is the only

one

one ſeparable by fire. The platina remaining after the ſeparation of the metals, proves unfuſible as at firſt.

Platina perfectly reſiſts the deſtructive power of lead and biſmuth, and the rapacious antimonial ſemimetal; which laſt has been hitherto eſteemed the ſevereſt teſt of gold, ſo as to have received the appellation of *balneum ſolius ſolis*, the bath which gold alone can ſuſtain, and in which it is waſhed from all kinds of impurities.

Since therefore platina mixed with gold is not diſcoverable by any of the operations by which that metal is uſually aſſayed or refined, or by the hydroſtatic balance; we hope that theſe papers, which contain part of the hiſtory of this extraordinary and hitherto unknown mineral, and the methods of diſtinguiſhing any ſophiſtications of gold made by its means, which might otherwiſe have paſſed undiſcovered, will be candidly received by this illuſtrious body, as a means of promoting that kind of knowlege, for which the Royal Society has been ever eminent, and peculiarly inſtituted.